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Since 2003, the United States has been fighting a two front operation in the Middle East that has resulted in the rapid development and employment of operationally relevant technologies. Unmanned Aerial Systems (UASs) are one such advent that adds an enormous situational awareness improvement for the ground commander. The Marine UAS squadron (VMU) in its current table of organization (TO) has supported this mission well. The recently released Marine Corps UAS CONOPS extends this model with the anticipation of Group 4 (weaponized) UASs to the VMU; however, training to this new capability is lacking. This document will attempt to examine the validity of new training for VMU personnel that will enable them to successfully execute the future mission of Group 4 weaponized UASs

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MASTER OF MILITARY STUDIES

TITLE:

United States Marine Corps Next Generation UAS Training

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OF THE REQUIREMENTS FOR THE DEGREE OF
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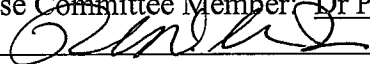**AUTHOR:**

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Executive Summary

Title: United States Marine Corps Next Generation UAS Training

Author: Major Nicholas O. Neimer, United States Marine Corps

Thesis: Since 2003, the United States has been fighting a two front operation in the Middle East that has resulted in the rapid development and employment of operationally relevant technologies. Unmanned Aerial Systems (UASs) are one such advent that adds an enormous situational awareness improvement for the ground commander. The Marine UAS squadron (VMU) in its current table of organization (TO) has supported this mission well. The recently released Marine Corps UAS CONOPS extends this model with the anticipation of Group 4 (weaponized) UASs to the VMU; however, training to this new capability is lacking. This document will attempt to examine the validity of new training for VMU personnel that will enable them to successfully execute the future mission of Group 4 weaponized UASs.

Discussion: UASs have been an enormous benefit and aid to commanders across the current fight in the Middle East. While the possible applications of these systems are seemingly limitless, to this point the tactics, techniques, and procedures (TTPs) have generally kept up with the technology and UAS capabilities. For the Marine Corps, this is about to change. The year 2016 has been forecasted as when the Marine Corps will receive a Group 4 UAS which will have the capability to be weaponized. Presently, VMUs accomplish their mission of Intelligence, Surveillance, and Reconnaissance (ISR) very well. The only required training presently accomplished involves basic operation of flying the aircraft and employing the sensor. However, once these UASs begin to carry target designators, air-to-ground ordnance, electronic attack systems, and logistics cargo, the stakes increase and the training requirements will expand accordingly. Training must be established which will adequately assimilate every facet of this new capability into the Marine Corps air/ground system. At the same time it is essential that this training not deviate from the culture that makes the Marine Air Ground Task Force (MAGTF) so lethal.

Conclusion: The United States Marine Corps prides itself on the capability of the close integration of every facet of fires organic to the MAGTF. This is unmistakable, for example, in the tradition that all Marine Corps Forward Air Controllers (FACs) are winged aviators. We must not lose the importance of ensuring that training supports this same tradition when applied to Group 4 UASs.

DISCLAIMER

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Acronyms

AR	Armed Reconnaissance
ATO	Air Tasking Order
AO	Area of Operations
BOT	Bomb On Target
BOC	Bomb On Coordinate
BHA	Bomb Hit Assessment
CAS	Close Air Support
C2	Command and Control
C3	Command and Control and Communications
CONUS	Continental United States
CONOPS	Concept of Operations
CFAAC	Combined Force Air Component Commander
DASC	Direct Air Support Center
DAS	Deep Air Strike
EA	Electronic Attack
EP	External Pilot
FAC	Forward Air Controller
FC	Fires Coordination
GPS	Global Positioning System
ISR	Intelligence Surveillance Reconnaissance
IR	Infrared
IO	Internal Operator
JTAC	Joint Terminal Attack Controller
LGB	Laser Guided Bomb
MAWTS-1	Marine Aviation Weapons and Tactics Squadron One
MAGTF	Marine Air Ground Task Force
MC	Mission Commander
MCTUAS	Marine Corps Tactical Unmanned Aerial System
MOS	Military Occupational Specialty
NAV	Navigation
OAS	Offensive Air Support
OIF	Operation Iraqi Freedom
OEF	Operation Enduring Freedom
PGM	Precision Guided Munition
RSTA	Reconnaissance Surveillance and Target Aquisition
S-2	Intelligence Section
SAR	Synthetic Aperture Radar
SCAR	Strike Coordination and Armed Reconnaissance
SIGINT	Signals Intelligence
T&R	Training and Readiness
TA	Target Acquisition
TAC(A)	Tactical Air Coordination (Airborne)
TACAIR	Tactical Aviation

TACC	Tactical Air Coordination Center
TACP	Tactical Air Control Party
TO	Table of Organization
TOT	Time On Target
TTP	Tactics Techniques Procedures
UAS	Unmanned Aerial System
UA	Unmanned Aircraft
USMC	United States Marine Corps
USAF	United States Air Force
VMU	UAS Squadron
WAMI	Wide Area Motion Imagery
WAAS	Wide Area Airborne Surveillance
WMC	Weapons Mission Commander
WIO	Weapons Internal Operator
WTI	Weapons and Tactics Instructor Course
WSO	Weapons Systems Officer

Introduction

"The robotic revolution is underway, yet there is no clear understanding as to what it will mean."

- Dr. Robert Finkelstein[1]

The advent of Unmanned Aerial Systems (UASs) has resulted in a revolution of modern combat. It has changed the way we look at the battlefield. The ability of commanders on the ground to have almost instantaneous information at their request is almost as addictive as a drug. The validity of this capability, however, is not to be denied. Technology combined with relatively low cost is allowing us to be able to lessen the risk of Americans in harms way and increase their capabilities to affect the enemy. The United States Air Force has progressed leaps and bounds in the acceptance of these systems into the combat environment over the past decade. Many in the service feel that they (UASs) "soon, they will be handling a major share of the service's strike mission."[2]

The United States Marine Corps is progressing in the right direction when it comes to implementation of UASs. Even with a comparatively limited integration of UASs in the recent past, the spatial awareness on the battlefield has been unprecedented. But unlike the Air Force, we in the Marine Corps must continue to focus training in order to support our most lethal weapon, the Marine Rifleman. The Marine Air Ground Task Force (MAGTF) is our greatest strength, which will only strengthen further as we move to increasing the numbers of UAS units. "The answer is through maximizing the strengths of each asset to achieve a whole..."[3] has always been the key to the success of the MAGTF. Marine Corps aviation is an instrument at the disposal of the ground commander, as is the UAS. We in the aviation community must understand and be able

to recommend and successfully integrate with the inevitable future of UASs in the MAGTF.

Today, a gap in training exists in the UAS community and will continue to grow in the near future. To date, the gap has been relatively transparent to us for a variety of reasons, the first of which is the permissive environment in which we are fighting coupled with the relatively limited role of current UAS employment -- primarily Intelligence, Surveillance, and Reconnaissance (ISR). Limitations in current UAS training would become immediately obvious if a UAS that has a strike capability as well as numerous other kinetic options was introduced into a more dynamic and fluid operational environment. By comparison, the USAF has a concept already written for 2046 with respect to employment and usage of UASs, specifically addressing future training and employment.

Presently, UAS squadrons in the Marine Corps (VMUs) and their operators accomplish the missions of ISR well. The VMU training has further increased the scope to include "call - for - fire" missions for indirect fire assets, target marking (with a laser/IR designator), and Tactical Aviation Coordination Airborne (TAC(A)). Historically, the VMU community has been operated from a Command and Control (C2) MOS perspective and under the direction of our Intelligence community (S-2). In order to harness the full capability of this asset, there must be a change, and it has significant implications for unit and individual training. Until very recently, the only training accomplished has involved basic operation of flying the aircraft and employing the sensor. Once these UASs begin to carry target designators, air-to-ground ordnance, electronic attack systems, ground mapping radars, and logistics cargo, the stakes will

increase. Training must be established that will adequately assimilate every facet of this new capability into the Marine Corps air/ground system. At the same time, it is essential that this training not deviate from the culture that makes the Marine Air Ground Task Force (MAGTF) so lethal. The future UAS issues that will become evident with the acquisition of more capable systems will be revealed in two ways. First, the present training for VMU personnel is not adequate to meet the needs of operating these future systems to their fullest capability. Second, the majority of personnel who comprise a VMU, specifically the officer corps, should have an aviation background and are permanently assigned to the unit. The following proposals made here will suggest near-term and long-term solutions to staffing and a solution to the training gap within the VMU. Specifically, this paper will suggest the introduction of additional required training for UAS personnel that will enable them to execute the future mission(s) of a Group 4 weaponized UAS, expected to arrive in the USMC inventory in 2016. This proposed training will build upon the current "Training and Readiness" (T&R) guidance for UAS employment. Unlike the USAF, the Marine Corps aviation community typically does not have an "adequate officer continuum to optimally staff a UAS unit."[4] This paper will further suggest both near-term and long-term solutions to provide a much needed permanent officer MOS in the VMU.

Background

"The Marine Corps, as the nation's force-in-readiness, must have the versatility and flexibility to deal with a situation at any intensity across the entire spectrum of conflict. This is a greater challenge than it may appear."[5]

- MCDP 1

The United States Marine Corps has been using UASs since the Persian Gulf War in the early 1990s. These systems were in place at the start of their operational history

and were generally known as Remotely Piloted Vehicles (RPVs). They were initially

used at the company level with "... great success."[6] This new capability was

immediately identified as a system that the intelligence community could use very well.

Through the 1990s, these systems grew in size and complexity, and were subsequently

assigned to the Marine Air Wing (MAW) as Unmanned Aerial Vehicle Squadrons

(VMU). Through OEF and OIF operations, technology continued to yield more complex

and robust systems which required more support at the squadron level.[7]

Presently, the Marine Corps owns and operates several UASs. These systems are

divided into categories (known as the Joint UAS Categorization) based upon the system

characteristics and capabilities, such as weight of the system, nominal operating altitude,

and nominal operating airspeed. These categories are broken up into five groupings.[8]

Table 1-1: Joint UAS Categorization

UAS Category	Max Gross Takeoff Weight	Normal Operating Altitude (Ft)	Airspeed	Representative UAS
Group 1	< 20 pounds	< 1200 AGL	<100 Kts	Wasp, Raven B
Group 2	21-55 pounds	< 3500 AGL	< 250 Kts	Scan Eagle
Group 3	< 1320 pounds	<18,000 MSL		RQ-7 Shadow
Group 4	> 1320 pounds		Any Airspeed	RQ-9 Reaper
Group 5		> 18,000 MSL		RQ-4 Global Hawk

Group 1 consists of UASs that are small and easily transported by a two-man

team and are organic to the infantry battalion. These systems are usually hand-held and

can be launched fairly easily by only two Marines. These systems are able to be fairly

mobile which gives the battalion level (and below) unit "around-the-corner / over-the-

hill" capability.[9] The intent is that Group 1 UAS will be utilized in Direct Support (DS)

of the maneuver units on the ground.

Group 2 UASs, such as the Scan Eagle, have been employed to augment VMU squadrons during the early stages of OIF and OEF. The Marine Corps does not operate a Group 2 UAS and has no plans to acquire one in the future.

The future of Marine Corps UAS procurement and expanding operational role will lie between Group 3 and Group 4 UASs, and is the focus of this paper. Historically, the Group 3 UAS that the Marine Corps operated with great success was the RQ-2 Pioneer. The commonly known Pioneer had been the UAS of choice but has been replaced by the Shadow (RQ-7B) which is "the current Group 3 system for the Marine Corps."[10] The Shadow, like the Pioneer, can be launched by runway, catapult, or rocket assist. Unlike the Pioneer, the later variants of the Shadow have an updated sensor suite and are capable of carrying larger payloads up to 100 pounds. The Shadow expands the operational role of Marine Corps UAS somewhat, as it not only accomplishes the traditional mission of ISR, but has the ability to perform Target Acquisition (TA) with an on-board laser designator / IR marker. Future payloads anticipated in the 2014 timeframe include "Synthetic Aperture Radar (SAR), Wide Area Motion Imagery (WAMI), Wide Area Airborne Surveillance (WAAS), and Signal Intelligence (SIGINT) payloads."[11] Of note, the Marine Corps is working on acquisition of a smaller Group 3 UAS for the regimental level. This system will not be discussed here.

The Group 4 UAS, also known as Marine Corps Tactical UAS (MCTUAS), is a larger and more capable UAS that is projected to be operational in the 2016 - 2020 timeframe (see Figure 3). The current Group 3 UAS, the Shadow, is the interim UAS until the projected Group 4 UAS can be operational and the Group 3 Small Tactical UASs (STUAS) are introduced in 2012 - 2015. The MCTUAS will not only have the

capabilities of Group 3 but will be able to perform precision strikes, Electronic Attack (EA), and Comm/Data relay with a flexible platform ability to add additional missions. This Group 4 UAS will clearly provide an organic capability to the Marine Corps unlike any before, and this new capability in no way compares to the current VMU tasking of the RQ-7 Shadow of basic Reconnaissance, Surveillance, and Target Acquisition (RSTA).[12]

Who Should be Trained?

"We should recognize that all Marines of a given grade and occupational specialty are not interchangeable and should assign people to billets based on specific ability and temperament."[13]

- MCDP 1

Present to 2016

Officers who typically staff VMU squadrons throughout the Marine Corps have been from the Military Occupational Specialty (MOS) 75XX (Aviation) or the 72XX (Command and Control) fields. There is currently no primary MOS for officers in the VMU and typically they are assigned to the unit strictly as a "B" (or secondary) billet from whatever their primary job had been, for a period of up to three years. After their tour was complete in the VMU they would return to their primary MOS. Conversely, enlisted have a designated MOS for the specialty fields of "UAS operator, maintainers, and avionics technicians"[14] and have had no manning issues comparatively to the officer cadre. With personnel always an issue that is constantly monitored across the Marine Corps, the future challenges of staffing VMUs will fall under similar scrutiny. There presently exist occupational specialties that are available for enlisted operators in the VMU. Marines have been offered lateral moves to the 7314 (IO) or 7316 (external operator) MOSs, and continues to be managed successfully by the enlisted manpower

division of the Marine Corps. The continuity issue will arise in the officer corps in the VMU as it will in many other aviation communities. Presently, there is no primary MOS for officers to staff a VMU. The MOS of 7315 is a secondary MOS, much like a FAC would receive after attending TACP school. In order for the VMU to be a successfully integrated member of the MAGTF, this approach must change.

Flights performed by UASs in theater have been relatively benign with respect to deconfliction. Knowledge of the theater airspace structure was only required at a relatively rudimentary level. UASs have generally been assigned a block altitude of airspace (ex 3,000 - 5,000) that all other aviation assets were aware of via the Air Tasking Order (ATO) and knew to stay clear. With the multi-role Group 4 UAS, no longer will the VMU community have the luxury of owning their own airspace with relatively clear separation from the manned (or other unmanned) aircraft in an Area of Operations (AO). Additionally, the potential for the release of weapons, as well as the host of other abilities that these systems can offer, passive ISR operations will rapidly turn into active weapons deployment, with resulting complexities in deconfliction. The operator(s) in the VMUs will have to not only understand how to employ air-to-ground weapons but how to communicate and integrate into the present battlefield. The reality is that, in the near future, this cannot be accomplished with non-aviation trained personnel.

Building off the current layout of a VMU squadron, we must first define and identify where the potential shortcomings will be in a squadron, both officer and enlisted. The Mission Commander, an officer and as the title implies, is responsible for the "overall mission conduct."[15] The Internal Pilot, typically enlisted, plans and "is responsible for the safe control and operation of all assigned UAVs."[16] And, the Payload

Operator, also enlisted, "is responsible for the efficient and effective use of the airborne sensor."[17] The Internal Operator, if qualified, can hold the responsibilities of both the Payload Operator and Internal Pilot. This paper will only refer to the Internal Operator. The External Pilot is responsible for the safe take-off and recovery of the UAS. The standard VMU table of organization (TO) for personnel and aircraft would maintain: (5) UASs, (5) Mission Commanders, (5) External Pilots and (33) Internal Operators.[18] During a mission, a crew would consist of two Internal Operators (IO), one External Pilot (EP) and the Mission Commander (MC).[19]

With the assumption that a certain percentage of Group 4 UASs be weapon delivery capable, a like percentage of the UAS operators must be trained in weapons delivery and the missions associated with it. As described above, the three individual members of a VMU crew have different responsibilities and may not require similar training. In keeping with the current training for the members of a UAS crew, it is logical to train the MC as well as the IO in weapons employment specifics. With respect to enlisted manning, it is reasonable to anticipate that there will be no manning shortage coming in the immediate future. This is primarily due to the greater numbers of enlisted personnel as well as the ease of changing MOSs. With respect to officers, in the near term, there will be an aviation shift and an opportunity for the VMU to make its mark in the MAGTF. With the sundown of the EA-6B Prowler scheduled for 2016 and the lessoning of Weapons System Officer (WSO) production in the F-18D Hornet community, it's reasonable to say that there is a significant knowledge base to tap into from these communities. In effect, these officers can cross-train into the "Weapons Mission Commander" (to be defined later) occupational specialty. The benefits of

maintaining these naval flight officer pipelines would be two-fold both near-term and long-term. After the recommendation is made to move the VMU under the wing, there will already be an inherent knowledge base of aviation operations in the Marine Corps.[20] Also, having a winged Marine Corps officer will be of supreme value in instilling the training required of Group 4 UASs and ultimately the VMU. This will ultimately help in bridging the gap in a platform that operates in an aviation environment but with limited aviation knowledge. A domestic and immediate example of this is the anticipated future FAA approval of UAS operations in CONUS National Airspace. Complimenting the Marine Corps UAS CONOPS, having winged aviators would only be a benefit.[21]

2016 and Beyond

As referenced earlier, a primary MOS exists for the operators of UASs in the VMU, but not for officers. With the potential of more complex systems and especially the future ability to fly the UAS in the national airway structure, the MC role in the VMU can no longer be thought of as a "B" billet. The individual who is ultimately responsible for the safe operation of the UAS is the MC. Serious consideration must be given to the creation of a permanent officer MOS in the VMU, with an associated training program. Taking this a step further, the officer must be able to accomplish many of the tasks that the traditional tactical aviator was trained to accomplish. Skills such as briefing missions, integration with other aviation assets, being fully proficient at Close Air Support (CAS), Tactical Air Coordination (Airborne) (TAC(A)), Deep Air Strike (DAS) and further in the future, Offensive Air Support (OAS). These skills cannot be taught in a couple months to someone who is not already an aviator.

In order to preserve the unmatched relationship between the Marine aircraft providing support to the Marine on the deck, a mindset shift must occur. To the ground commander, there should be no difference in quality of support between an F-18, AV-8B, AH-1, or a weaponized UAS when it checks in with the Joint Terminal Attack Controller (JTAC) on the ground. It takes pilots of manned tactical aircraft years to be proficient at the many potential missions that an armed aircraft could perform in combat. The training of officers in a VMU squadron should be no different. From 2016 and beyond, the Marine Corps should continue with similar manning numbers in the Naval Flight Officer training pipeline. This would allow the creation of a primary MOS for officers permanently staffing the VMU.

How Should They be Trained?

"Training programs should reflect practical, challenging, and progressive goals beginning with individual and small unit skills and culminating in a fully combined arms MAGTF"[22]

- MCDP 1

As was alluded to earlier, the intent of the suggestions made here are to compliment the current training in the VMU, and to open discussion for future additions to training VMU personnel. The focus of the training should be in the Tactics, Techniques, and Procedures based on current TACAIR doctrine in the delivery of precision guided munitions and directed energy weapons while fully integrating with all aviation and ground assets. In order to understand what must be added to the training of VMU operators and MCs, one must understand the current mission: "Support the MAGTF commander by providing day and night aerial reconnaissance, surveillance, target acquisition (RSTA), indirect fire adjustment, bomb hit assessment (BHA) and

support of the rear area security plan during expeditionary operations or joint and combined operations during Visual Meteorological Conditions (VMC)."[23]

The proposed additions that will be suggested here are purely a point to proceed from. Determination as to crew performance will have to be evaluated over time to identify and evaluate appropriate changes to the syllabus. The addition of events to the training syllabus should focus on the MC and IO billets, specifically for the introduction of kinetic training. In a typical T & R syllabus, a pilot or operator is exposed to procedures and instruction in a building-block approach. The typical matrix or convention for defining a flight training event would be a three-letter designator with a three-digit number indicating the level of difficulty or complexity. An example of this convention from the UAS T & R Manuel for an IO training event would be a "NAV - 111." The "NAV" indicates that this flight instructs the operator under instruction in the basic skill of navigation. The "111" indicates the specifics of the flight are two-fold. As training progresses, the complexity and difficulty of the skill sets also increase. A "100" level flight indicates that the flight is basic in nature and, in the example above, the last two digits further define the actual training that is to be accomplished. Therefore, using our example from above, a NAV - 111 will "Introduce basic fundamentals of range navigation."[24] Training for the IO in the weapons employment pipeline should begin once the operator is qualified as both a Payload Operator (sensor management) and Internal Pilot (operation of the UAS). There are two reasons for this. Operators are qualified to not only fly the UAS but to manipulate the sensors on board, and these are skills that will be crucial in understanding weapon delivery geometry. Furthermore, the

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typical IO (or IO under instruction) will have much more flight experience operating a UAS than an individual only qualified as a Payload Operator.

There are two phases in the existing syllabus for the IO in which this training would be appropriately introduced. The 300 or "Core Skills Advanced" and 400 or "Core Plus" levels of training are ideal situations where these additions could be made. It is at the end of the 400 level Core Plus where the IO will receive his/her weapons qualification (see attachment 1). In the 300 level the operator is conducting training that would allow him/her to be qualified as an IO as discussed earlier. Ground schooling of weapons employment should be incorporated in this stage. This will allow the instructor to determine whether or not the IO under instruction will have the capacity to continue to progress toward "weapons qualification" while he/she completes the existing IO syllabus. The addition of Tactical Flight Operations (TFO) 326 and 327 to the current syllabus would consist of the ground schooling required before moving on to the 400 level. The ground schooling content would include but not be limited to: laser / IR operations, weapons characteristics (PGM), basic weaponeering (weapon to target matching), and basic CAS procedures. Once the operator is determined to be capable of performing these duties he/she can proceed as a qualified IO to the 400 level of practical application as a "Weapons Internal Operator" (WIO) under instruction.

The 400 level or "core plus" skill of the weapons instruction will build upon what has been learned by the operator in the 300 level ground schooling. The Fire Coordination (FC) skill set in the 400 level of instruction should contain practical weapons delivery procedures. Again, each flight or event will build upon the previous. The syllabus will begin with a ground school period of instruction which will cover in

detail the actual employment of all the weapons on the UAS as event FC-437 "Basic Weapon Employment." This could include the communication procedures that are required between the IO and MC. Crew coordination can also be emphasized as the prospective WIO is introduced to a fully qualified weapons mission commander. The next event of FC-438S (simulator) will entail the simulation of weapons delivery. One of the major cost benefits of the UAS is that a large preponderance of events can be flown simulated. Unlike a manned system, a UAS operator is in the exact environment when in a simulator or flying an actual mission. However, it will be emphasized that all check rides will be "live" events utilizing the actual UAV and potentially live weapons. In other words, an actual UAS would not be utilized, but would focus the procedure and requirement to successfully employ laser-guided bombs as well as air-to-ground missiles such as the "Hellfire". In this early stage, the scenario for the simulation will be fairly benign. The student will be given a single target to "service" which would enable the instruction to focus on repetition. Many aviators in TACAIR know this weapons delivery pattern as "circle the wagons" because it allows for multiple target runs.

Once the delivery of weapons has been mastered, the WIO under instruction will move on to CAS procedures. Much like the basic weapons delivery in the prior two events, the CAS events will consist of a ground school and two simulator events. The ground school event, FC-439 "CAS Employment", will encompass all of the tenants of close air support. A particular focus of training that a Marine should receive is centered on communications, holding procedures, medium and high threat CAS, and the nine-line format. This, of course, would all be based off of the most current Joint CAS publication at the time. The first simulator event, FC-440S, will leverage heavily off the basics of

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CAS ground school. The major focus here will be CAS communications (crew coordination), control measures, 9 - line execution, and timing. The purpose of this simulator event is to, through repetition, build the foundation for successful execution of delivering ordnance close to friendly troops. A FAC (either simulated or actual) will facilitate as the controlling authority. The lessons learned in ground school will be put to practice plus the student will be exposed to multiple PGM and LGM deliveries while utilizing the EO and IR capabilities of the system. Practical application of Joint CAS publication 3-09.3 in which "planning is critical to the integration of UA into CAS operations and requires a thorough understanding of specific UA capabilities in order to make sound tactical decisions. UA operators must understand the tactical situation and be integrated into mission planning."[25] The second CAS simulator, FC-441S, is performed ideally with an actual FAC or JTAC, but now introduces multiple CAS aviation assets as well as an urban terrain. This is probably one of the most difficult events to coordinate with external agencies, but is an absolute necessity. In the near future, the ability will exist to link simulators from different communities and practice together in any given scenario. In essence, these simulators will be "networked" and "all TACAIR/Attack platforms" will be able to train together even if they are not based in the same place.[26] This simulator will also introduce the WIO in training the concept of laser designation for another CAS platform. This is known as "buddy lase" and is a technique that is difficult to master even in a manned platform. The final event, FC-442, will encompass all of the prior simulator-required tasks. The only difference would be actually flying the aircraft and delivering ordnance vice just a simulation. One may argue that a simulator is sufficient enough for one to prove their proficiency. But, having used simulators in

manned aviation, it is my experience that they could never replace the value added by actual operation and functioning of every facet of the mission from take-off and landing to ordnance delivery. This event is the culmination and would be the "check ride" for the WIO designation. The proposed additions for the WIO qualification to the existing VMU T&R manual can be found in Figure1.

The MC qualification would have initially a similar path in order to gain the "Weapons MC" (WMC) designation. The major difference between the MC and the IO is that the MC is not typically manipulating the controls of the UAS, but he/she has overall responsibility for the safe conduct of the mission. Also, the MC could be in charge of up to two separate systems at a time, or more. Hence, the focus of the WMC under instruction will primarily be in communications, crew coordination, weapons knowledge, and tactical decisions. The basic MC qualification is attained at the completion of the 200 level syllabus. As the MC progresses through the current 300 and 400 level T & R events, it will be determined which MCs are candidates for the weapons qualification. The future layout of the VMU will have many potential areas of "expertise" such as logistical or cargo capabilities.[27] Thus, a balance of weapons qualifications will have to be dependent upon how many UASs are going to be weaponized. The career progression for an officer in a VMU should be: 200 level complete = basic MC qualified, 400 level complete = "Weapon MC" qualified, and 500 level complete = weapons instructor. This paper will address the training which will be accomplished within the VMU. Much like the manned aviation community, a WTI designation at MAWTS-1 in Yuma, AZ should be available for future WMC in a VMU.

The WMC under instruction will participate in the same ground school courses that the WIOs attend in the 300 level. A base of knowledge of the specific weapons systems must be attained by attending TFO-326 and 327 as a joint class for both the WIO and the WMC. Even though the prospective WMC does not operate the equipment directly, he/she must be apart of this instruction. As he/she progresses into the 400 level, the WMC under instruction will continue to participate in similar detailed weapons instruction along with the fully qualified WIOs. And in turn, as WMCs become fully qualified they will take part in the training of prospective WIOs. This concept is very similar to the two-seat F-18D in which a junior pilot would have an experienced Weapons Systems Officer (back seater) and vice versa. This will not only foster an early appreciation of crew coordination and the WIO - WMC relationship during the earliest lessons learned, but it also allows for both to understand their own crew responsibilities in basic weapons delivery operations.

The prospective WMC will continue the training into the "core plus" events. Here, the prospective WMC will be further exposed to more complex missions in which MAGTF aviation assets often participate. Furthermore, many of these missions are supremely well-suited for a UAS. Extended loiter times as well as the ability to communicate on multiple frequencies near-simultaneously provides another advantage to battlefield situational awareness. The recommendation that the WMC be an officer with an aviation background, and more ideally an aviator, will be addressed in the next section; but, for the purposes of this discussion it is assumed that this is the case. Beyond the semi-simplistic training in a low threat environment to this point, the future WMC will undergo a series of evolutions that will expose him/her to complex scenarios that

require outside integration even beyond a Marine Corps trained FAC on the ground. This more focused series of events will highlight Tactical Aviation (TACAIR) missions, such as medium to high threat CAS, Armed Reconnaissance, Strike Coordination Armed Reconnaissance (SCAR), Deep Air Strike (DAS), and Tactical Air Coordination (Airborne) (TAC(A)).

Much like the convention used for the WIO syllabus, the WMC qualification will be attained after completion of the 400 level. Before the practical application of flights, a series of lectures and "chalk talks" will be afforded the students prior to any evaluated flights. FC-402 and FC-403 will be ground school. These classes will discuss and test concepts before they are put into practice. FC-402 will be very similar to FC-437 and FC-439 for the WIO and will discuss the basic CAS environment to include: weapon delivery methods and types, JCAS doctrine, med/high threat CAS, 9-line format, and time-on-target. During this instruction, this WMC will focus more on the integration of other aircraft as well as surface-to-surface fires such as artillery and mortar fires. The student will be able to build on the previous events, FC-306 and FC-307, in which "call for fire" and fires adjustment have already been learned. The concept of "buddy-lase" will be introduced in which the UAS will "illuminate" a target with its laser designator while supporting a weapon from another aircraft to the target. And finally, as UAS sensors become more accurate, coordinate generation for using GPS weapons will be introduced.

The second ground school course, FC-403, will discuss operations out of a restrictive fires environment. Tactics for armed reconnaissance in a designated kill-box will include items such as attack profiles, kill box communications procedures, and threat

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vehicle ID. This training will be critical to support the potential role for a UAS as a "strike coordinator" (SCAR) while in a kill box as other aviation strike assets arrive on station. The focus here will be airspace management, battlefield handover procedures, target prioritization, and as always ISR. The last critical skill that should be taught is that of Tactical Air Coordination (Airborne) (TAC(A)). Much like in SCAR, leveraging the UASs superior loiter time, a UAS can direct strike aircraft where to proceed for follow-on tasking. As an extension of the Marine DASC, the UAS can also serve as a TAC(A) with its ability to transmit on several frequencies and be a vital link in command and control. The prospective WMC must have excellent knowledge of all communications procedures, all airspace procedures, all CAS / AR / SCAR and TAC(A) procedures in order to be fully utilized.

The practical portion of the instruction will continue with events that mimic the ground school lessons, and in keeping with further training of crews, only fully qualified WIOs will be utilized for prospective WMC flights. Of the four advanced skill sets, each event will involve a simulator and flight evolution with the same criteria. While not a primary topic of this paper, note that the software must exist to allow such simulations to take place. The first two events will be FC-404S and FC-405 simulator and flight, medium to high threat CAS, to demonstrate proficiency beyond the permissive environment with a minimal threat which enables the majority of tactics that we have seen on today's battlefield. Specific focus should be on the 9 - line as the standard method used to communicate all pertinent information to an attacking aircraft in a minimal amount of time. It should be required that all (or as many as possible) of the supporting arms be involved in this flight evolution. Integration with indirect fire, attack

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helicopters, and fixed wing attack aircraft will sufficiently expose the student. Reference to Joint Publication 3-09.3 is heavily emphasized here.

The next two events are FC-406S and FC-407 and will focus on Armed Reconnaissance and SCAR. Attack profiles that UASs should fly when prosecuting targets of opportunity will be the primary focus of this training event. In addition, the positive identification of the enemy prior to attack as well as accurate coordinate generation will be emphasized. A thorough understanding of "killbox" and "keypad" airspace management will be tested. And finally, the ability to direct attack aircraft to previously identified targets will be a focus of this flight.

The final simulator, FC-408S, and subsequent flight, FC-409, will be the "check ride" for the prospective WMC. These two events will be flown in a highly communication-intensive environment. The previous events will have provided the building blocks and the required situational awareness to successfully coordinate airspace, with multiple terminal attack controllers (FACs / JTACs), indirect fire support assets, with CAS assets, for the DASC/TACC, and in-flight reports through the C3 system. The proposed additions for the WIO qualification to the existing VMU T&R manuel can be found in Figure 2.

Why Should They be Trained?

"The purpose of all training is to develop forces that can win in combat."[28]

- MCDP 1

To this point in Marine Corps employment of UASs, they have operated mostly free from the restrictions that are placed upon manned aircraft. They typically have been assigned a block of altitude and been able to maneuver fairly uninhibited while other

aircraft are made to steer clear. As UASs get larger and faster, they will soon be crossing over into the operating realm of the manned aircraft. As Marine Corps UASs gain the ability to employ weapons and affect the battlefield in any environment, they will be crossing into the offensive sphere of the MAGTF. We have all heard stories of the random CFACC-owned Predator employing a Hellfire on a target in the Marine AO. But, imagine that same Predator under the control of a Marine Corps-trained crew who knows Marine Corps doctrine as it relates to combined arms and is able to perform all the functions expected of a tactical aircraft. This will not only involve a change in the training environment but in the mindset that the Marine Corps needs to begin creating today in the VMU community. Not all Group 4 UASs will be weaponized and that it is reasonable to assume that not all members of a UAS crew are required to be trained in offensive weapons employment. This mix will have to be determined in the future, dependent on the number of Group 4 UASs acquired and how many of those are used for offensive operations. However, the overall training implementation will need to address all of the potential roles of the MCTUAS.

Conclusion

"As much as possible, employment techniques and procedures should be developed concurrently with equipment to minimize delays between the fielding of the equipment and its usefulness to the operating forces. For the same reason, initial operator training should also precede equipment fielding"[29]

- MCDP 1

Regardless of whether the employment concepts for advanced UASs are currently accepted across the Marine Corps, these systems are going to be part of the battlefield in the very near future. The fact is, we in the Marine Corps have only realized a small fraction of the potential for unmanned systems. With the November 2009 release of the

"Concept of Operations for United States Marine Corps Unmanned Aircraft Systems Family of Systems", we must further the development of techniques and procedures that demonstrate effective integration of this CONOPS into the future for our Corps. This must be done while building upon, not forgetting, our past.

The Marine Corps legacy includes detailed and lethal integration across all facets of warfighting that can be brought to the battlefield. We have a history of embracing technology as a way to improve our lethality against an ever-changing foe. The introduction of a new method of warfare should not change in any way our "understanding of the nature of war."[30] And, although technology progresses at a staggering rate, there should be no change in our understanding that success in conflict is achieved by humans, not technology. The UAS is merely another tool of warfare; it is neither the answer to combat nor a replacement for Marines, and should not be treated as such. But, as with any new tool, effective employment on the battlefield can only be achieved via well-conceived and implemented training for the Marines who will employ it.

While advanced UASs may bring next-generation technology to the battlefield, they are still air-based platforms and require the proper training to operate in the air structure and contribute reliably and effectively to new missions such as CAS. When pilots in the late stages of OIF were asked what they are the most afraid of; the majority said, it was a midair collision with a UAV. The potential risks associated with a future Group 4 UAS, if not trained effectively, are even more significant to both air and ground elements. We must not pass a tipping point where training might be sacrificed in favor of rapid deployment of a desired technology. Not only is the safety of our forces at stake,

but the ability to perform as a single MAGTF would be at risk. Training the MAGTF to

realize the potential of these new and capable systems, to the standard we have set over

the course of our history, must be considered a Marine Corps necessity.

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Figure 1: Proposed Weapons Internal Operator T&R Additions

New Event	Goal / Event Description	Forum
TFO-326	Laser and IR OPS / Weapon Characteristics & Employment	Ground School
TFO-327	Weaponeering / CAS procedures / Communication / Crew Coord	Ground School
FC-437	Delivery Methods & Geometry / Flight Patterns / Buddy Lasing	Ground School
FC-438S	LGB Delivery / PGM Delivery	Simulator
FC-439	9-Line / Med & Hi Threat CAS / TOT / Radio procedures	Ground School
FC-440S	Holding & Pattern procedures / Type I,II, & III CAS / BOT & BOC	Simulator
FC-441S	Urban CAS / Buddy Bomb & Buddy Lase	Simulator
FC-442	EO&IR OPS / Urban & Rural	Designation Flight

Figure 2: Proposed Weapons Mission Commander T&R Additions

New Event	Focus / Event Description	Forum
TFO-326	Laser and IR OPS / Weapon Characteristics & Employment	Ground School
TFO-327	Weaponeering / CAS procedures / Communication / Crew Coord	Ground School
FC-402	CAS Doctrine / Weapon Employment / Med&High Threat CAS	Ground School
FC-403	AR / SCAR / Kill Box Procedures / TAC(A)	Ground School
FC-404S	9-Line / Med & Hi Threat CAS / TOT / Radio procedures	Simulator
FC-405	9-Line / Med & Hi Threat CAS / Urban & Rural CAS / Radio procedures	Flight
FC-406S	AR / SCAR / Kill Box Procedures / Attack profiles / Tgt ID	Simulator
FC-407	AR / SCAR / Kill Box Procedures / Attack profiles / Tgt ID	Flight
FC-408S	Tactical Air Coordination (TAC(A)) / Communications / Targeting	Simulator
FC-409	CAS / AR / SCAR / TAC(A)	Designation Flight

Figure 3: "UAS Family of Systems ... estimated timeline to support operational concepts and the UAS transformation in 2010 and beyond."
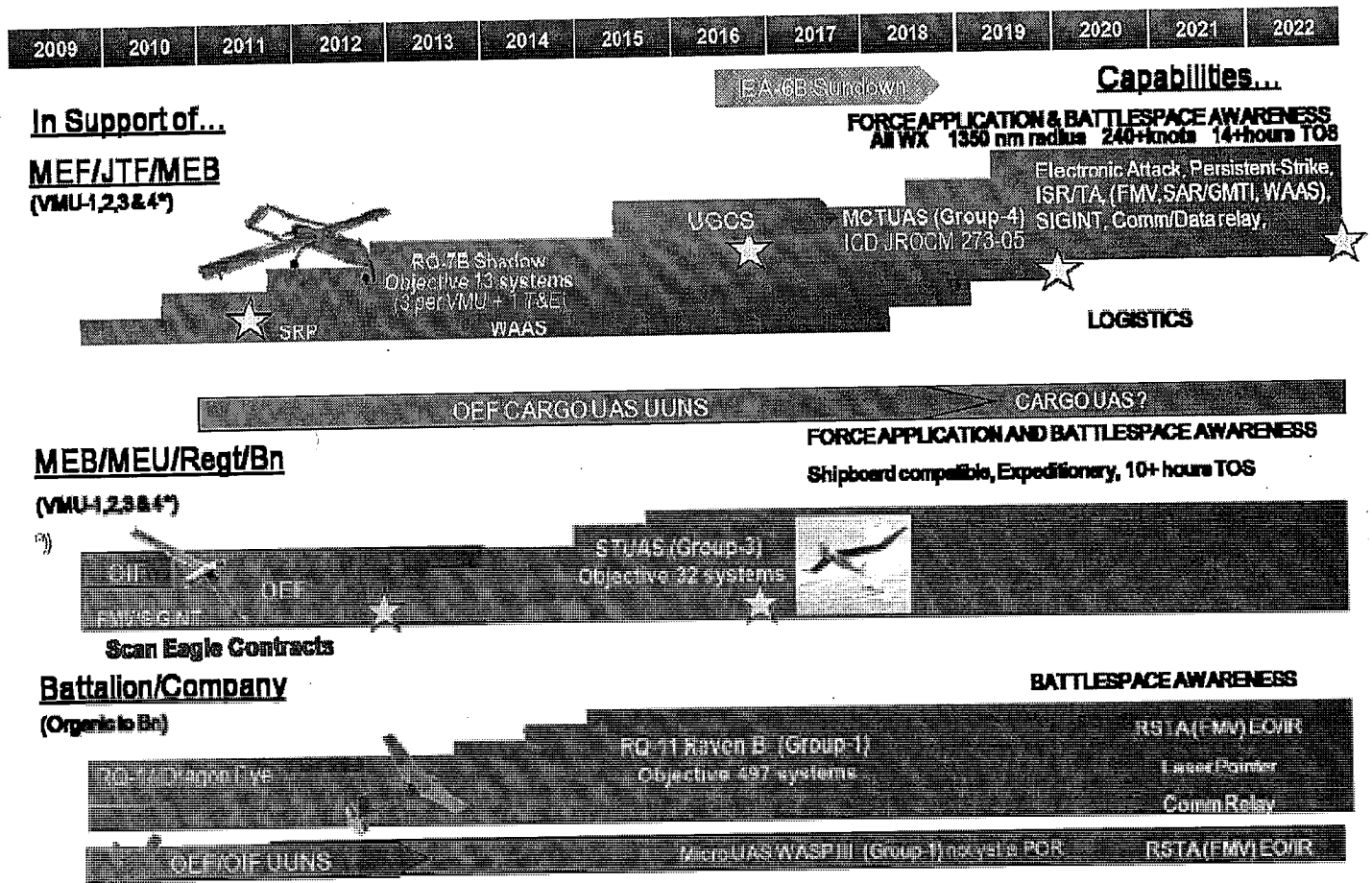
Source: Marine Corps Combat Development Command. *Concept of Operations for United States Marine Corps Unmanned Aircraft Systems Family of Systems*. Quantico, VA: Fires and Maneuver Integration Division Capabilities Directorate, 2009, Figure 4-1, p 13.

Notes

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